



Environmental Effects of Dredging Technical Notes

CORPS OF ENGINEERS' PROCEDURES AND POLICIES ON DREDGING AND DREDGED MATERIAL DISPOSAL (THE FEDERAL STANDARD)

PURPOSE: This note describes the Federal Standard pursuant to Corps' technical considerations and policies with regard to the disposal of dredged material in accordance with the Clean Water Act (CWA), which provides for selecting the least costly dredged or fill material disposal alternative, consistent with sound engineering practices and appropriate environmental quality standards. This approach also generally applies to assessments conducted in accordance with the Ocean Dumping Act, even though the following discussion centers on the CWA.

BACKGROUND: Navigable waterways of the United States have and will continue to play a vital role in the Nation's development. The Corps, in fulfilling its mission to maintain, improve, and extend these waterways, is responsible for the dredging and disposal of large volumes of sediment each year. Nationwide, the Corps dredges about 230 million cubic yards (c.y.) in maintenance and about 70 million c.y. in new dredging operations annually at a cost of about \$450 million. In addition, 100-150 million c.y. of sediments dredged by others each year are subject to permits issued by the Corps. In accomplishing its national dredging and regulatory missions, the Corps has conducted extensive research and development in the field of dredged material management (Engler, Patin, and Theriot 1988). Regulations, policies, and technical guidance prepared and used by the Corps are based on operating experience and results from extensive research programs. Federal expenditures on dredged material research, monitoring, and management activities have cumulatively exceeded \$100 million. Additional research regarding current issues relative to the Corps' national dredging program is an ongoing and dynamic process. Corps' policy is evolving as dredged material research provides a better understanding of the environmental impacts that can be anticipated from dredging and dredged material disposal. Corps' national policy is reflected in the final regulation for Corps' operation and maintenance dredging of Federal navigation projects published 26 April 1988 (33 CFR Parts 209, 335, 336, 337, and 338) and in the final rule for the Corps' regulatory program published 13 November 1986 (33 CFR Parts 320-330).

ADDITIONAL INFORMATION: This technical note was written by Dr. Robert M. Engler, Dr. Tom Wright, Dr. Charles R. Lee, and Dr. Tom M. Dillon. For additional information contact Mr. Dave Mathis (CECW-D), commercial or FTS: (202) 272-8843; or Dr. Wright (601) 634-3708; or Dr. Engler, manager of the Environmental Effects of Dredging Programs, (601) 634-3624.

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Corps Authorities and Responsibilities

The Corps has regulatory responsibility for all dredged material disposal activities that occur within the waters of the United States. This authority stems from Section 10 of the River and Harbor Act of 1899, Section 404 of the Clean Water Act (CWA) (Public Law 92-500, as amended), and Section 103 of the Marine Protection, Research, and Sanctuaries Act (Public Law 92-532, as amended). The Corps' regulatory responsibilities involve review of some 10,000-30,000 permit applications each year as well as appropriate maintenance of, and improvements to, the 25,000-mile congressionally authorized Federal navigation system serving 42 of the 50 states. Section 404 authorizes the Secretary of the Army to issue permits for the discharge of dredged or fill material into waters of the United States in accordance with the Section 404(b)(1) Guidelines (subsequently referred to as the Guidelines) and other requirements of Federal law as discussed below. The Guidelines require compliance with several conditions prior to allowing disposal of dredged material in waters of the United States. Compliance requires the avoidance of "unacceptable adverse effects" to the aquatic environment. The Guidelines specify four conditions of compliance ("restrictions on discharge" per 40 CFR 230.10):

1. There is no other practicable alternative that would have less adverse impact on the aquatic environment.
2. The disposal will not result in violations of applicable water quality standards after consideration of dispersion and dilution (40 CFR 230.10(b)(1)), toxic effluent standards, or marine sanctuary requirements, nor will it jeopardize the continued existence of threatened or endangered species.
3. The disposal will not cause or contribute to significant degradation of the waters of the United States.
4. All appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic environment.

Findings for compliance with condition 2 are based in large part on Section 401 of the CWA, which allows the individual states to establish State water-quality standards. All State-established standards must, at a minimum, be as stringent as established Federal water-quality criteria. However, the individual states have the option under the CWA, and several have so elected, to establish more stringent State standards to reflect the overriding priority

that these individual states have for environmental protection. Unless waived on a case-by-case basis by the State, or on such occasions overridden by critical factors in the national interest, State 401 Water Quality Certification must be obtained prior to initiation of any Federal or non-Federal dredged material disposal activity which occurs within navigable waters of the United States (40 CFR 230.10(b)(1)).

The findings of compliance with condition 3 are to be based, in part, on "evaluation and testing" of the proposed dredged material (Subpart G of the Guidelines). The assessment provided by Subpart G is used to determine the potential for significant* adverse effects of dredged material disposal on the aquatic environment (factual determinations required by Part 230.11). According to the Guidelines (40 CFR 230.61), specific evaluation procedures, including chemical and biological tests to determine compliance with the Guidelines and State water-quality standards, are furnished by the Corps as the permitting authority.

The Corps' final decision on any proposed dredged material disposal activity, however, must be based on a broad public interest review which not only considers information derived from chemical and biological tests but which also considers an evaluation of the probable impact, including cumulative impacts of the proposed activity, on the public interest. In addition, embodied within this public interest review, is a Corps requirement to ensure that the substantive concerns of over 30 Federal environmental laws, Executive Orders (EOs), and other requirements are properly addressed, whenever applicable. These include the Coastal Zone Management Act, the Marine Protection, Research, and Sanctuaries Act, the Endangered Species Act, the Fish and Wildlife Coordination Act, EO 11990 for Federal projects (Protection of Wetlands), and EO 11988 (Floodplain Management). While each of these Federal Statutes (including the CWA) is generally resource specific in regard to environmental protection, the Corps' public interest review necessitates full consideration of all relevant information before rendering a decision.

The expected benefits resulting from the proposal must be balanced against its foreseeable detriments. All factors which may be relevant to the proposed activity will be considered, including conservation, economics,

* The term "significant" has no statistical relevance or connotation; it is used in the same general sense as "substantive."

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esthetics, historic properties, fish and wildlife values, flood hazards, floodplain, national defense, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and the general needs and welfare of the people.

The weight given to each factor is determined by its importance and relevance to a particular proposal. A specific factor may be given great weight on one proposal, while it may not be present or as important on another. The Corps' (District Engineer's) final decision will reflect the national concern for both protection and utilization of important resources. As such, the Corps is neither a proponent nor opponent of individual permit proposals, nor of congressionally authorized dredging projects.

Section 404(b)(2) allows the Corps to issue permits otherwise prohibited by the Guidelines, based on an overriding consideration of the economics of anchorage and navigation.

Federal Standard

The Corps, as agency policy, uses a Federal Standard philosophy and process in evaluating proposed dredged material disposal activities relative to the general public interest. This "Federal Standard" process is intended to meet environmental requirements at the least cost within a consistent national framework. The Federal Standard provides a reference point for Corps field offices in addressing regional issues in dredged material management. The intent of the Federal Standard is to ensure a necessary level of national consistency in the evaluation and undertaking of proposals for dredged material disposal (e.g., testing procedures), while also ensuring a necessary level of flexibility by the Corps field offices to account for region-specific considerations. However, significant deviations from national testing and evaluation guidance require consideration of cost, utility of information, and full technical explanation and documentation in the Section 103.

For proposed permit activities, Corps regulations (33 CFR 320-330) require that unnecessary testing procedures and regulatory controls be avoided, while simultaneously ensuring that overriding rights and interests of the general public are fully protected in the waters of the United States. Such rights include, but are not limited to, preservation of water quality, national security, and interstate commerce. These considerations are

discussed in more detail in a Corps Regulatory Guidance Letter of 19 August 1987, RGL-87-8, "Testing Requirements for Dredged Material Evaluation."

Permit activities

Evaluation of Section 404 permits, for which an application has been made to the Corps, normally will proceed concurrently with the processing of applications for permits for other Federal, State, and/or local authorities (33 CFR 320.4(g)), such as the State 401 Water Quality Certification. The applicant for a Section 404 permit will receive direction from the Corps as the permitting authority (40 CFR 230.61) concerning appropriate tests that must be conducted on material proposed for dredging. This note summarizes the Corps' national guidance given to its field offices on technically acceptable dredged material evaluation procedures. Also to be provided to permit applicants, where applicable and appropriate, are Corps recommended actions which can be undertaken to minimize any identified adverse effects of discharges of dredged material as provided under Subpart H of 40 CFR 230. Depending on the results of the general public interest review, the Corps may issue, issue with conditions, or deny individual permits. In those permit cases where denial of State Certification has occurred or is imminent or a state has not concurred in Coastal Zone Management concurrence, the Corps may either immediately deny the Section 404 permit without prejudice, or may continue processing the permit, concluding either in a denial as contrary to the public interest or denying without prejudice, noting that, except for the State 401 Certification denial or Coastal Zone Management nonconcurrence, the Section 404 permit could be issued.

Federal projects

For Federal projects, the Corps is required to use the Section 404(b)(1) Guidelines to determine the appropriate test and evaluation procedures for delineating the least costly, environmentally acceptable disposal alternative as well as to demonstrate compliance with applicable State water-quality standards.

The Corps submits its findings concerning project compliance with the 404 Guidelines and State water-quality standards to the State via the Public Notice process along with a request for State Water Quality Certification. The certification request also includes relevant information to demonstrate compliance with applicable State water-quality standards. The existing regulatory framework given in the CWA requires that a Corps-preferred alternative

be developed before the request for State Water Quality Certification. However, this does not preclude informal coordination with the State at a much earlier stage in the project evaluation, and indeed such informal coordination is fully encouraged, particularly if it will shorten the environmental compliance process for the Corps project.

The Corps Public Notice and Findings of Compliance or Non-Compliance with the Section 404(b)(1) Guidelines serves as a point of reference in any subsequent negotiations with the State on additional requirements or conditions which the State may require for Water Quality Certification.* The Corps' District Engineer has the necessary discretionary authority to develop additional evaluative information requested by the State, which in the District Engineer's opinion, is technically justified and reasonably related to enforcement of the State's water-quality standards. The legislative record for the CWA provides congressional recognition that Federal project costs may be increased in some instances to address reasonable and technically appropriate State water-quality concerns. However, if the District Engineer determines that on a case-by-case basis a State's requirements are excessive or technically unjustified, he may request that the State or project sponsor fund the additional costs associated with any such requirement. In such cases where the State or project sponsor agrees to fund the additional costs, the District Engineer must also determine and notify the State and project sponsor that such additional costs may affect the continued economic viability of the Federal project in question. In the event that the State or project sponsor does not agree to fund the additional cost, the District Engineer may defer dredging while determining whether the dredging project is economically justified and is not contrary to the public interest.

For Federal dredging projects (where Congress has allocated Federal funds), the Corps is responsible, in developing dredged material disposal alternatives, for considering all facets of the dredging and disposal operation, including technically appropriate test and evaluation procedures, cost, engineering feasibility, overall environmental protection, and the no-dredging option. The alternative selected by the Corps should be the least costly alternative, consistent with sound engineering and scientific practices and

* This procedure is also followed for concurrence with certification of consistency for approved State Coastal Zone Management Programs.

meeting applicable Federal environmental statutes. This becomes the "Federal Standard."

Corps of Engineers Technical Disposal Guidelines

The following paragraphs present the procedures by which the Corps regulates and manages the disposal of dredged material in the waters of the United States under its authorities and policies described above. These procedures, which evolved over the past decade, are subject to additional change and modification as new information and technology are developed and adequately evaluated.

Section 404 of the CWA provides that guidelines developed by the US Environmental Protection Agency (EPA) in conjunction with the Corps be applied by the Corps in selecting disposal sites and in the permit application review process. EPA published technical guidelines in 1975 and revised these in 1980 for use by the Corps in making the required ecological evaluation of a proposed discharge activity. The Corps issued final regulations for the Section 404 regulatory program in July 1977 to be used in evaluating proposed discharges of dredged or fill material into inland and ocean waters. In May 1976, the Corps issued an interim guidance manual as specified in the Federal Register to initiate technical implementation of the program.

The Section 404(b)(1) Guidelines as well as the 103 criteria are based on the following factors from Section 403(c) and 102(a) of the Clean Water and Ocean Dumping Acts, respectively:

1. The effect of disposal of pollutants on human health or welfare, including but not limited to plankton, fish, shellfish, wildlife, shorelines, and beaches.

2. The effect of disposal of pollutants on marine life including the transfer, concentration, and disposal of pollutants or their by-products through biological, physical, and chemical processes; changes in marine ecosystem diversity, productivity, and stability; and species and community population changes.

3. The effect of disposal of pollutants on esthetics, recreation, and economic values.

4. The persistence and permanence of the effects of disposal of pollutants.

5. The effect of the disposal at varying rates of particular volumes and concentrations of pollutants.

6. Other possible locations and methods of disposal and recycling of pollutants including land-based alternatives.

7. The effect of alternate uses of the oceans, such as mineral exploration and scientific study.

These "legal/technical" considerations form the framework from which the ecological evaluations must be developed.

The Section 404(b)(1) Guidelines recognize that compliance evaluation procedures will vary depending on the seriousness of the proposal's potential for unacceptable adverse impacts (40 CFR 230.10) and provide general guidance for evaluation and testing. Pursuant to the Guidelines, specific evaluation procedures, including chemical and biological tests, are furnished by the District Engineer on a case-by-case basis ("interim guidance by the permitting authority," 40 CFR 230.61).

To assist the Corps in the overall long-term management of the disposal of dredged material, a management strategy was developed by the US Army Engineer Waterways Experiment Station (Francine et al. 1985). This strategy has been adopted as Corps policy and is incorporated by reference in 33 CFR Parts 209, 335, 336, 337, and 338, 26 April 1988 (Corps Dredging Regulation). The steps for managing dredged material disposal follow:

1. Evaluate contamination potential.
2. Consider potential disposal alternatives.
3. Identify potential problems.
4. Apply appropriate testing protocols.
5. Assess the need for disposal restrictions.
6. Select an implementation plan.
7. Identify available control options.
8. Evaluate design considerations.
9. Select appropriate control measures.

Following development, the management strategy was used as a framework for an example application for highly contaminated material at Commencement Bay, WA (a Superfund site), under the sponsorship of the State of Washington Department of Ecology, and the Corps (Peddicord et al. 1986). This example application considers all alternatives for disposal and provides detailed

technical rationales and flowcharts for evaluating disposal alternatives based on the results of appropriate testing.

Since the mid-1970's the Corps has been regulating the disposal of dredged material under the authority of 33 CFR Parts 320 through 330 and 40 CFR Part 230 and revised in 1980 for waters of the United States and under the authority of applicable sections of 40 CFR 220-229 (1973) and revised in 1977 for ocean dumping. In fulfilling the obligations and responsibilities mandated by those authorities, the Corps has conducted extensive research under the Dredged Material Research Program (Saucier et al. 1978) and continues to conduct research under the Environmental Effects of Dredging Programs (Engler, Patin, and Theriot 1988), and provides field assistance and management activities under the Dredging Operations Technical Support Program. In addition, it has published two guidance manuals, one for the CWA (Environmental Effects Laboratory 1976) and a joint manual with EPA for ocean dumping (Environmental Protection Agency/and US Army Corps of Engineers 1977); the latter provides much more detailed guidance than the former. Although these documents were state of the art when published, subsequent operational experience has led to changes in specific application. In particular, there has been a tendency for Corps coastal districts to use, depending on the subject of concern, portions or all of the testing procedures in the Ocean Dumping Implementation Manual for 404(b)(1) determinations whenever estuarine or marine waters are involved. Although a major reason for this is the detailed guidance, others include similarities between the requirements of the 404 Guidelines and those in Section 102(a) of Public Law 92-532 (the Ocean Dumping Act) and the fact that saline waters are involved. Additionally, shortly after the issuance of the Corps/EPA implementation manual on ocean dumping, the Corps and EPA were sued by the National Wildlife Federation. The suit was based on the technical validity of the testing procedures and interpretation of test results. Judgment was made in favor of the Corps and EPA and there has been no further challenge. Because of the above factors, the ocean dumping testing procedures and interpretive approaches have been in widespread use and have led to the informal adoption of the general testing and evaluation protocol from ocean dumping to 404(b)(1) evaluations.

This should not be construed to imply that the ocean dumping procedures/interpretation are "required" or "mandated" for 404(b)(1) evaluations. These procedures should be considered in light of project-specific concerns and,

where appropriate, may, in part or in whole, be used. However, they do, *de facto*, constitute an acceptable and widely used technique which has withstood court challenge and for which a major technical data base exists. That no absolute procedure exists for 404(b)(1) evaluations is further evidenced by cooperative efforts currently in progress between the Corps and EPA to establish standard testing and evaluation procedures.

Tiered Testing and Assessments

The national comprehensive testing strategy supported by the Corps is a tiered approach (Table 1) with each successive tier being based on a "reason to believe" that there is potential for unacceptable adverse effects. Each tier is fully optional and may be subsequently eliminated if there is sufficient information available to provide an adequate assessment for that tier or if there is no reason to believe that there will be unacceptable adverse effects associated with that tier or disposal concern. Such multiple tests are clearly allowed by 40 CFR 230.4-1 ("No single test or approach can be applied in all cases to evaluate the effects of proposed discharges of dredged or fill material," and "Suitability of the proposed disposal sites may be evaluated by the use, where appropriate, of sediment analysis or bioevaluation."). However, such tests are subject to the condition that "In order to avoid unreasonable burdens on applicants in regard to the amounts and types of data to be provided, consideration will be given by the District Engineer to the economic cost of performing the evaluation, in light of the information expected and the contribution of that information to the final decision, and the nature and magnitude of any potential environmental effect."

The first tier of the existing approach consists of an initial evaluation of available information to establish whether there is a "reason to believe" that contaminants are or are not present. This tier is commonly referred to as the "exclusion clause" (40 CFR 230.4-1(b)(1)). If there is no reason to believe that contaminants are present and if certain other conditions are met, including grain size and chemical/physical similarity of the dredged material and the substrate at the disposal site, no further testing is required. If there is reason to believe that contaminants are present, or if sufficient information is not available, a second tier or evaluation may be conducted which consists of a bulk sediment analysis. Should sufficient

Table 1
Comprehensive Testing Approach for Aquatic Disposal
as Part of the Federal Standard*

<u>Tier 1</u>	Initial evaluation of existing information and "reason to believe there is contamination."																	
<u>Tier IIA</u>	Bulk sediment inventory. Reason to believe dredged material is more contaminated than disposal site sediment and potential unacceptable adverse effects may occur.																	
<u>Tier IIB</u>	Elutriate analysis. Chemical analysis for contaminant(s) of concern, contrast to appropriate water-quality criteria and/or standard with consideration of mixing. Comparison to receiving water quality and/or bioassay when no standard exists.																	
<u>Tier III</u>	Biological tests.																	
<u>Tier IIIA</u>	Acute bioassay toxicity tests (as appropriate): <table border="0" style="width: 100%;"> <tr> <th style="text-align: left; width: 40%;"><u>Water Column (Elutriate)</u></th> <th style="text-align: left;"><u>Select Species</u></th> </tr> <tr> <td>(Mixing considered)</td> <td>(As necessary)</td> </tr> <tr> <td>Dissolved phase</td> <td>Mysid shrimp</td> </tr> <tr> <td>Suspended solids phase</td> <td>Grass shrimp</td> </tr> <tr> <td></td> <td>Bivalve</td> </tr> <tr> <td></td> <td>Fish</td> </tr> <tr> <td></td> <td>Larva, bivalve</td> </tr> <tr> <td></td> <td>Other</td> </tr> </table>		<u>Water Column (Elutriate)</u>	<u>Select Species</u>	(Mixing considered)	(As necessary)	Dissolved phase	Mysid shrimp	Suspended solids phase	Grass shrimp		Bivalve		Fish		Larva, bivalve		Other
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	Other																	
	<u>Benthic</u>																	
	Solid phase	Mysid shrimp																
		Amphipod																
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		Clam																
		Polychaete																
		Other																
<u>Tier IIIB</u>	Bioaccumulation. <table border="0" style="width: 100%;"> <tr> <th style="text-align: left; width: 40%;"><u>Water Column</u></th> <th style="text-align: left;"><u>Select Species</u></th> </tr> <tr> <td>Suspended solids phase</td> <td>Grass shrimp</td> </tr> <tr> <td></td> <td>Clam</td> </tr> <tr> <td></td> <td>Polychaete</td> </tr> <tr> <td></td> <td>Other</td> </tr> </table>		<u>Water Column</u>	<u>Select Species</u>	Suspended solids phase	Grass shrimp		Clam		Polychaete		Other						
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* Table 1 presents the general types of tests and evaluations in a tiered and sequential basis where each tier (step) is, however, optional and may be eliminated or chosen as appropriate. Test species tested are not mandatory but are shown for consideration to a proposed disposal site region.

information be available from previous testing and evaluation, no additional chemical analyses are necessary.

The bulk sediment analysis is essentially an inventory of contaminants of concern and is used to compare the chemical composition of the dredged material to the composition of the material at the disposal site with emphasis generally placed on heavy metals, PCBs, PAHs, pesticides, and other substances of ecological or human health significance. If substantially greater concentrations are observed in the dredged material and there is reason to believe that the substances are bioavailable and sufficient information is not available, a third tier of testing may be required. This tier includes testing for water column impacts and/or benthic impacts.

If there is concern regarding water column impacts, an elutriate test may be performed to evaluate contaminant release into dredging or disposal site water. The results of the elutriate test are compared to water quality standards after consideration of mixing as described in the 404(b)(1) Guidelines. If there are no water-quality standards or the standards are thought to be inappropriate or inadequate, a water column liquid and/or suspended particulate phase bioassay may be conducted along with consideration of mixing. Again, depending on where the concern lies, the water column bioassay may address the dissolved constituents and/or the suspended solid particulate phase.

If there is concern regarding impacts to benthic organisms, a benthic bioassay may be conducted. In general, for a comprehensive assessment of potential impacts, three organisms are generally used: a filter-feeder, a deposit-feeder, and a burrowing species. These relate to potentially different ecological niches at the disposal site. In addition, a mysid shrimp may be considered and has been widely used as an internal standard and to form a basis for quality assurance.

If there is a reason to believe that bioaccumulation is of concern, a second component of the third tier consists of evaluating the potential uptake of contaminants. This may be done either in the field or in the laboratory, whichever is more appropriate. If done in the laboratory, it is customary to use survivors of the toxicity bioassays for bioaccumulation assessment if sufficient biomass is present in the survivors.

The tiered testing approach described above is essentially the procedure followed for the evaluation of the aquatic disposal alternative in the

development of the Federal Standard for a given dredging project. This approach should be applied consistently to each and every dredging project, Federal or permit. The approach is flexible to some extent in allowing consideration of the three phases of the aquatic environment (liquid, suspended solids, and solid), as appropriate, that potentially could be impacted by the discharge of dredged material. Testing of the appropriate phase is determined by the reason to believe that a potential for unacceptable adverse impacts in one or more phases could occur. Additional flexibility is incorporated in the approach in relation to the selection of bioassay species to be used in the tests. Species can be selected such as a bivalve, polychaete, and a crustacean (mysids, amphipods, shrimp) or other available, appropriate, developed and evaluated local species. The intent is to evaluate the potential impact on a deposit-feeder, a burrower, and a suspension-feeder representative of major ecological compartments.

The following discussion addresses in more detail the interpretation of bioassay test results from the tiered testing approach used to evaluate the aquatic disposal alternative portion of the Federal Standard. Additional detail on the evaluation of the aquatic disposal alternative can be found in Peddicord et al. (1986).

If there is reason to believe that the dredged material contains contaminants of concern at concentrations higher than those contained in the disposal site sediment and these contaminants are potentially bioavailable and could result in a significant* adverse impact, then bioassay tests should be conducted. The bioassay tier testing is used to determine whether there is reason to believe contaminants in the dredged material will result in an unacceptable adverse impact to the water column and/or the benthic component of the aquatic disposal environment. The water column consists of a dissolved phase and a suspended solid particulate phase. An overwhelming preponderance of evidence from years of studies has demonstrated that the potential of water column impacts of contaminants released from dredged material disposal are generally negligible. While this evidence does not unequivocally prove that water column impacts will not occur with aquatic disposal, it does indicate that such impacts are sufficiently unlikely that the District Engineer

* The term "significant" has no statistical relevance or connotation; it is used in the same general sense as "substantive."

normally should conclude that it is appropriate to focus evaluation on the other issues rather than testing for potential water column impacts in association with disposal in aquatic sites where the majority of the material is deposited on the bottom and the remainder is subject to rapid dispersion and dilution.

In many cases it will be possible to assess the potential for water column impacts on the basis of previous water column testing and characteristics of the disposal site without conducting additional sediment-specific testing. However, there may be a reason to believe that the suspended solid particulate phase of the water column may result in a potential unacceptable adverse impact to the disposal environment. If this is the case, the suspended solids bioassays may be conducted. Likewise, if there is reason to believe that unacceptable adverse impact may occur in the solid phase, then a solid-phase bioassay should be conducted.

If the results of the bioassay tests show unacceptable toxicity to the test species, further testing may be required. In the case of suspended solids phase bioassay testing, consideration of a mixing zone at the disposal site should be evaluated to determine whether an acceptable mixing zone is available to eliminate significant adverse impacts due to potential toxicity at the disposal site. If unacceptable toxicity is shown in the solid phase test and mortality is sufficiently elevated above control and/or reference, a significant impact has been shown.

If unacceptable toxicity is not observed in the solid phase test species and there is reason to believe that there is a potential for bioaccumulation, or the results of the bioassays are not conclusive, further testing may be required. The surviving bioassay animals may be analyzed for bioaccumulation after exposure to the dredged material for an appropriate length of time.

Bioaccumulation by bioassay species exposed to the dredged material is compared to that of species exposed to disposal site sediment or an appropriate reference site in the disposal site environment.

The above discussion has addressed the first four steps of the Management Strategy (Francingues et al. 1985). Additional information on the need for restrictions and control measures for aquatic disposal and the evaluation of other disposal alternatives can be found therein and in Cullinane et al. (1986). A more comprehensive discussion of the interpretation of test results is provided by Peddicord et al (1987).

Innovative Assessment Techniques

The enactment of Public Laws 92-532 (the Marine Protection, Research, and Sanctuaries Act of 1972) and 92-500 (the Federal Water Pollution Control Act Amendments of 1972) required the Corps to participate in developing guidelines and criteria for regulating dredged and fill material disposal. The focal point of research for these procedures is the Corps Dredged Material Research Program (DMRP), which was completed in 1978; the ongoing Corps Environmental Effects of Dredging Programs (Engler, Patin, and Theriot 1988) includes the Dredging Operations Technical Support (DOTS) Program, the Long-Term Effects of Dredging Operations (LEDO) Program, the Wetlands Research Program (WRP), and the recently completed Corps/EPA Field Verification Program (FVP).

While these research programs have allowed the Corps to develop an extensive and effective set of testing protocols and evaluation procedures, there continues to be a requirement for additional research. Less expensive, faster, and improved techniques for predicting the effects of disposal of dredged material are needed. Accordingly, innovative development of new and refined evaluation procedures are being undertaken through appropriate R&D programs of the Corps. However, until new procedures are proven through adequate documentation, existing techniques must be relied upon.

Summary

The "Federal Standard" guidance serves as a consistent national framework and reference point for Corps field offices which provides for consideration of regional issues in dredged material management. In applying the process to different projects or regions of the country, it may be necessary to adopt specific testing procedures consistent with the Federal Standard Philosophy. Corps field office evaluations must be consistent with the national procedures, defensible in light of research results and scientific judgment, cost and time effective, and of direct use in decisionmaking.

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